material in minute concentrations, have to be mined and processed. However, as this activity takes place far away from the people who use the electricity, we tend to overlook it.

In the comparison of the *land-use* by solar and nuclear power-plants presented above we have omitted one important difference. So far, the results were obtained under the assumption that the land, when it is not needed any longer for energy production, will again be available for other purposes. This assumption is valid for solar technologies, but applies only partially for the nuclear fuel-cycle. Table S(A)-1 of the GESMO report lists, as the permanently committed land, $1.82 \times 10^8 m^2$ for 4000 GWy of electrical energy produced. This is mostly land covered by mill tailings which will emit radon-222 gas resulting from the decay of thorium-230, whose radioactive half-life is 83,000 years—*see* pp. IV H-13 *et seq.* of the GESMO report. Hence, this land cannot be used for any human activity for hundreds of thousands of years, and therefore should be at least partly included in the determination of the *land-use* of the nuclear fuel-cycle. During the first 600 years, for instance, this permanently committed land represents a *land-use* of $1.82 \times 10^8 m^2 \times 600y = 1.1 \times 10^{11} m^2y$, which just about halves the average energy produced per *land-use*, thus lowering this ratio to $18.2\ W/m^2$. After 5,600 years, this figure will have dropped to $3.5\ W/m^2$, or one-tenth of the figure obtained by ignoring the long-term land commitment in the nuclear fuel-cycle—and so on, as long as we care to feel responsible for the mill tailings we have left behind.

It is thus evident that, by including the permanently committed land in the comparison, we obtain the amazing result that solar energy requires much less land than does nuclear. This argument is actually less absurd than it may appear at first as land used for the mill tailings will not only be unusable for any other human purposes, but, more importantly, will have to be cared for in perpetuity. The tailings piles, which the authors of GESMO foresee to be 11 m high on the average, will have to be stabilized in order to avoid erosion, and this will be a continuing process.

Various methods for the management of mill tailings have been studied (Sears *et al.*, 1975). None of these methods, however, can be considered as a permanent disposal of the waste, in the sense that they would require no further care in the future. These authors have also pointed out that the only method which might appear to be truly permanent, i.e. burying a mixture of the mill tailings with cement in abandoned deep mines, may be impractical as most mines collect water, which may cause leaching. The same leaching problem would arise in the case of burial in abandoned deep open-pit mines.

The potential adverse health effects caused by atmospheric dispersal of radon gas emanating from inadequately protected tailings piles have recently been discussed (Comey, 1975; Pohl 1976*a*, 1976*b*). It now appears that these wastes may represent a considerable burden for the economics of nuclear energy, even if they are properly protected and stabilized, because of the land which they occupy. Specifically, one should ask whether the price for which uranium oxide is sold on the international market does indeed properly reflect the permanent commitment of land arising from its production and use as a source of energy*.

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Hunt for the Japanese Sea-lion

The World Wildlife Fund has made a grant for a hunt for the Japanese Sea-lion on the east coast of South Korea, the only region where the species may still survive. The Japanese Sea-lion (*Zalophus californianus japonicus*) is a subspecies of the Californian Sea-lion, well known for its spectacular circus performances. Its last known breeding stronghold was Dokto (Takeshima) Island, which lies between Japan and Korea.

Professor Kim Hon Kyu, formerly Professor of Zoology, Ewha Womens' University, will coordinate efforts to establish whether the Sea-lion is still to be found at Dokto Island or along the precipitous east coast of Korea where it used to feed. The work will include 24-hours observations at Changho, which is considered the most likely place for these animals to survive. Checks will also be made of capture records of marine mammals for the past ten years along the coast.

Although there have been reports of sightings, it is thought that there may have been confusion with Steller's Sea-lion (*Eumetopias jubata*) or the Northern Fur-seal (*Callorhinus ursinus*). If the Japanese Sea-lion is proved to survive, it is hoped that the Government of the Republic of Korea will declare it a National Monument and arrange for its conservation.

The project is part of the World Wildlife Fund's marine campaign under the slogan 'The Seas Must Live', which seeks to raise 10 million dollars for conservation of threatened marine life.

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